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PHYSICS AND MATHEMATICS

No. 40

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CONTENTS	PAGE
Crystals and Semiconductors	1
Electricity and Magnetism	3
Lasers and Masers	4
Magnetohydrodynamics	19
Mechanics	30
Molecular Physics	31
Nuclear Physics	33
Optics and Spectroscopy	36
Superconductivity	41

Crystals and Semiconductors

USSR

UDC 621.382.2:535.376

MONOLITHIC LIGHT EMITTING DIODES ON EPITAXIAL $\text{GaAs}_{1-x}\text{P}_x$ FILMS DOPED BY THE GAS-DISCHARGE PROCESS

Minsk IZVESTIYA AKADEMII NAUK BELORUSSKOY SSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 5, Sep-Oct 77 pp 73-76 manuscript received 27 Oct 75

OSINSKIY, V. I., KATSPOV, F. M., and PRIVALOV, V. I., Institute of Electronics, Academy of Sciences of the Belorussian SSR

[Abstract] A study was made to determine the feasibility of producing efficient light emitting devices with a monolithic structure by the gas-discharge doping process. Solid solutions of gallium arsenide-phosphide were crystallized with proper orientation into 50 μm thick films on GaAs substrates and then doped with selenium from gaseous H_2Se . The phosphorus content in these epitaxial films was varied from 5 to 70%. For determining the dependence of the glow characteristics on the impurity distribution and the defect distribution, the photoluminescence spectra of the films and of the substrate were measured as well as the electroluminescence spectrum of a monolithic p-n junction structure on such a substrate. The half-power width of the electroluminescence spectrum was found to be 135 \AA , with a 15:1 ratio of peak emission (8670 \AA and 8850 \AA) to extrinsic emission (8720 \AA). Figures 2; references 6: 4 Russian, 2 Western.

USSR

UDC 533.9.01

DEPENDENCE OF THE PINCH EFFECT IN INJECTED PLASMA ON THE CRYSTAL DIMENSIONS

Tashkent IZVESTIYA AKADEMII NAUK UZBEKSKOY SSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1977 pp 88-89 manuscript received 7 Jul 76

MUMINOV, R. A., GULAMOV, SH. A., KATULEVSKIY, YU. A., and KOGAN, YA. M., Physico-technical Institute imeni S. V. Starodubtsev, Academy of Sciences of the Uzbek SSR

[Abstract] Since most earlier research concerning the pinch effect in a non-degenerate electron-hole plasma produced by double injection of carriers had been done with thin crystals (half thickness smaller than the bipolar carrier diffusion path), a study was made to determine how the shaping of double-injection paths and the distribution of carriers due to the pinch effect depend on the transverse crystal dimensions. Analytically, simultaneous solution of the current equations, the continuity equation, and the field (Maxwell) equations yields a current-voltage characteristic which, for both thin and thick crystals, first follows the two-thirds power law and then becomes linear. Experimentally, the current-voltage characteristic of InSb p-i-n structure with a 0.2x0.6 mm cross section and a carrier concentration of $4 \cdot 10^{13} \text{ cm}^{-3}$ was measured at 77 K. A pinch effect was established,

corresponding to the linear range of this characteristic, and then cancelled by means of a parallel magnetic field of $1.6 \cdot 10^4$ A.m. Figures 1; references 4: 2 Russian, 2 Western.

USSR

AN INSTRUMENT FOR VISUALIZING THE X-RAY TOPOGRAPHIC PATTERNS IN P-N STRUCTURES DURING THE FABRICATION PROCESS

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR, FIZIKA in Russian Vol 12, No 4, pp 278-283 manuscript received 28 Apr 76

SHABOYAN, S. A., Yerevan Special Design and Engineering Office of Industrial Television

[Abstract] The x-ray topographic method according to A. P. Lang or G. Borrman is useful for determining the volume-defective structure of single crystals after each semiconductor fabrication stage. This method has been improved to greatly reduce the exposure time and thus make feasible an observation of fast processes. The essential component of the new instrument, called a lithocon, is a quick-response vidicon for scanning the fast photosensitive x-ray film and sending video signals to a television memory. The schematic diagram and the voltage-current characteristic of this instrument are shown. It can serve both research and industrial purposes. Figures 5; references 8: 2 Russian, 6 Western.

Electricity and Magnetism

USSR

UDC 538.561

EXPERIMENTAL VERIFICATION OF THE THEORY OF RADIATION GENERATED BY COMPTON ELECTRON CURRENTS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 77 pp 30-34 manuscript received 5 Aug 76

GANDEL'MAN, G. M., IVANOV, V. V., MEDVEDEV, YU. A., STEPANOV, B. M., and FEDOROVICH, G. V., Moscow

[Abstract] In order to verify the theory of radiation generated by a Compton electron current flowing in air near a pulse source of α -radiation, it is necessary to find that general property of the signal which, independently of the particular current characteristics, does not vary with assumptions or from one experiment to another. Such a property has, indeed, been found and the validity of the theory thus established. A situation is considered where radial currents are generated while a source at a certain distance above a base surface of infinitely high electrical conductivity emits into air a spherically symmetric flux of α -quanta and where the asymmetry which ensures radiation of wave fields is due to the presence of that base surface. The radiating currents are assumed to be symmetric above the base surface and are characterized as a pulse with duration of 10^{-7} - 10^{-6} s moving at the velocity of light with an amplitude which far away from the source decreases sufficiently fast to ensure convergence of the integrals in the expression for the vector potential. The experiment consisted in recording such a signal. Figures 3; references 7: 4 Russian, 3 Western.

USSR

UDC 621.396

VISUALIZATION OF RADIO FIELDS IN REAL TIME

Minsk DOKLADY AKADEMII NAUK BELORUSSKOY SSR in Russian Vol 21, No 10, Oct 77 pp 904-906 manuscript received 3 Jun 77

BELKIN, V. G., KLYUCHNIKOV, A. S., and KUKHARCHIK, P. D., Scientific Research Institute of Applied Problems in Physics, Belorussian State University imeni V. I. Lenin

[Abstract] Diffraction problems cannot be solved analytically, except in a few cases with idealizing approximations, so that experimental methods of measuring the spatial structure and the polarization pattern of electromagnetic fields are sought. The probe method has several drawbacks, when applied to fields within the microwave range, mainly on account of inevitable distortions and resulting errors. The thermal method is preferable, owing to the feasibility of simultaneously recording the field structure over the entire test surface. The practicality of this method has been demonstrated in an experiment with double-exposure holographic interferometry, using a helium-neodymium laser so that the diffraction field does not emit radiation during the first exposure. Typical interferograms at a wavelength's distance from circular, square, and triangular apertures are shown here. The sensitivity, the dynamic range, and the resolving power of this method all depend on the recording medium and the photographic film material. Figures 2.

Lasers and Masers

USSR

UDC 533.9:533.21

CALCULATION OF UNSTEADY AXISYMMETRIC PLASMA JETS DURING OPTICAL DETONATION

Minsk DOKLADY AKADEMII NAUK BELORUSSKOY SSR in Russian Vol 21, No 6, Jun 77
pp 503-506 manuscript received 23 Aug 76

ROMANOV, G. S. and STANKEVICH, YU. A., Scientific Research Institute of
Physical Problems, Belorussian State University imeni V. I. Lenin

[Abstract] An analytical study is made of the dynamics of a plasma jet formed by light impinging on an absorbent barrier. The case of an axisymmetric geometry and a fully developed shielding effect is considered, corresponding to the typical action of a cylindrical light beam on a target. The problem is formulated in terms of gas-dynamic equations in Eulerian variables and cylindrical coordinates, with the plasma jet either partially or completely absorbing the incident radiation while losing its energy by both the retardation and the photoelectric mechanisms. These equations, with the appropriate initial and boundary conditions have been solved numerically by the "large particles" method. On the basis of such calculations, pressure and temperature fields can be mapped in r,z-coordinates and the total gas energy as well as the plasma emittance can be plotted as functions of time. This establishes the feasibility of numerically simulating the processes occurring in real two-dimensional photoerosion jets during their strong interaction with incident radiation. Figures 2; references 12: 11 Russian, 1 Western.

USSR

UDC 535.33:621(373.8+373.44)

DYNAMICS AND ENERGY CHARACTERISTICS OF A PULSE LASER WITH ACTIVE SPECTRUM PHASING

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22, No 10, Oct 77 pp
1707-1712 manuscript received 9 Dec 76; after revision, 16 May 77

ANIKEYEV, B. V., Uzhgorod State University

[Abstract] An experimental study was made to determine the energy characteristics of a ruby pulse laser with active spectrum phasing and the effect of this mechanism on the laser dynamics. The feasibility has been established here of stimulating emission of giant (about 6 J/cm^2) ultrashort (about 10^{-10}s) pulses with a lower pumping threshold energy than required for emission of smooth giant pulses. The results are interpreted in terms of fluctuating initial conditions of stimulated emission above the self-excitation level. Although both emission modes are correlated, no direct relation is found between their energy characteristics and their different pumping thresholds. Figures 2; references: 7 Russian.

USSR

UDC 621.378

EMISSION OF STIMULATED RADIATION DUE TO SIMULTANEOUS EXCITATION OF COMPLEX MOLECULES BY RADIATION AT VARIOUS FREQUENCIES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 27, No 10, Oct 77
pp 704-707 manuscript received 31 Dec 76

GRUZINSKIY, V. V. and PALTARAK, N. M.

[Abstract] Fluorescence of organic solutions and vapors is quenched by additional exposure to radiation at a frequency ν_1 not within the $S_0 \rightarrow S_1$ absorption band, during excitation of their molecules with radiation at a frequency ν_2 causing an $S_0 \rightarrow S_1$ transition. The effect of simultaneous excitation at two frequencies, one of them the pumping frequency, on the stimulated radiation is also of interest. Accordingly, a study was made to establish whether there is a correlation between the form of an $S_0 \rightarrow S_n$ absorption spectrum and the intensity of $S_1 \rightarrow S_n$ absorption at frequency ν_1 . Used as test substances were coumarine and its derivatives, in which double the frequency of a ruby laser $\nu_2 = 2\nu_1$ falls within the band of intensive $S_0 \rightarrow S_1$ absorption and the sum frequency $\nu_1 + \nu_2$ falls within the band of an $S_0 \rightarrow S_n$ absorption of a different intensity. The existence of a definite interrelation between the intensity of $S_1 \rightarrow S_n$ absorption at frequency ν_1 and the form of the $S_0 \rightarrow S_n$ absorption spectrum with respect to the sum frequency $\nu_1 + \nu_2$ has, indeed, been established on the basis of tests with coumarine, rhodamine, and 3-aminophthalimide in alcohol solutions. Figures 2; tables 1; references 14: 8 Russian, 6 Western.

USSR

UDC 621.378.325

DYNAMICS OF THE LUMINESCENCE SPECTRUM AND THE EFFECTS ON THE LASER EMISSION SPECTRUM

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 27, No 4, Oct 77
pp 697-703 manuscript received 6 Dec 76

MORGUN, YU. F., MURAVITSKIY, M. A., and RYZHECHKIN, S. A.

[Abstract] An experimental study was made of amplified luminescence, the shaping of its spectral contour prior to emission in various resonators, and the effect of its spectral width attained before emission on the spectral contour of the subsequent stimulated radiation. Unstable resonators were used, an opaque convex spherical mirror and a plane mirror, so that oscillation modes could be easily selected, the radiation could be "spread" over the entire active specimen, and the emitted pulse could be made sufficiently narrow. Ruby rods with a 0.05% Cr content and sapphirized ends cut at the Brewster angle were used as active elements. The pumping pulse was matched so as to make the gain nearly equal to the loss factor without stimulating emission. The laser was

tested with three most common shutters: a passive translucent filter, a rotating Q-switch prism, and an optoelectric shutter. The spectral contour of amplified luminescence has been found to narrow down only when the Q remains larger than zero from the instant of tube ignition to the instant of monopulse extinction. It has also been established that, for producing radiation with a narrow spectrum, the laser must be equipped with resonators where the contour of amplified luminescence narrows down appreciably during the pre-emission stage. Figures 4; references 13: 10 Russian, 3 Western.

USSR

UDC 621.375.82

DISTRIBUTED-FEEDBACK DYE LASERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 27, No 4, Oct 77
pp 634-646 manuscript received 1 Jun 77

RUBINOV, A. N. and EFENDIYEV, T. SH.

[Abstract] Significant developments have been made since 1973 in experimental research and design of distributed-feedback lasers on dyes such as ethanol solutions of rhodamine. Such lasers consist basically of a thin-film cell and a prism. According to the Bragg condition, the ratio of emission wavelength to pumping wavelength is proportional to the ratio of refractive indexes (dye solution and prism material) at their respective wavelengths and inversely proportional to the sine of the incidence angle of the exciting beam at the prism-solution interface. The emission spectrum is wider than the pumping spectrum, the ratio of their widths being equal to the ratio of the respective wavelengths. The width of the emission spectrum is also strongly affected by the angular divergence of pumping beams in the plane of the interface. Of special interest is a pumping spectrum with a discrete structure. The characteristics of several dye lasers have been explored and feedback induced by pumping found to be a practically very useful mechanism for stimulating emission. Figures 7; tables 1; references 26: 14 Russian, 12 Western.

USSR

UDC 539.26

SOME ANOMALIES IN THE STRUCTURE AND IN THE PROPERTIES OF TANTALUM FOIL
IRRADIATED BY LASER PULSES IN AIR

Minsk DOKLADY AKADEMII NAUK BELORUSSKOY SSR in Russian Vol 21, No 6, Jun 77
pp 528-531 manuscript received 15 Sep 76

ALEBASTROVA, YE. P., DAVYDOV, G. V., MIRKIN, L. I., and SMYSLOV, YE. F.,
Moscow State Pedagogical Institute imeni V. I. Lenin

[Abstract] A study was made of tantalum foil irradiated by laser pulses, tantalum being very hardenable under laser action and chemically very active at high temperatures. The test specimens were 100 μm thick, of technical purity, and had been annealed in vacuum at 1200°C for 30 min. Infrared pulses ($\lambda = 1.06 \mu\text{m}$) 10^{-3} s wide with 30 or 300 J beam energy were generated by a GOS-30 M or a GOS-301 laser respectively. A subsequent metallographic examination revealed grain rotation and a high degree of plastic deformation. High-energy laser pulses had also produced cracks running always parallel to the zones of plastic deformation. Microhardness tests revealed an appreciable hardening, the amount depending on the irradiation mode. An x-ray examination revealed a widening of low-index diffraction lines and their shift toward lower Bragg angles. Figures 2; tables 1; references: 3 Russian.

USSR

UDC 535.14:621.001

EXCITATION THRESHOLD AND OUTPUT POWER OF A GAS LASER WITH 2-PHOTON SPATIAL
PERIODIC PUMPING

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA SERIYA 3, FIZIKA, ASTRONOMIYA in
Russian Vol 18, NO 2, Mar/Apr 77 pp 78-80 manuscript received 27 Oct 76

LYAKHOV, G. A., SVIRKO, YU. P. and SUYAZOV, N. V., Department of General
Physics and Mathematical Mechanics

[Abstract] The object of this work is calculation of the characteristics of a laser with distributed feedback, achieved by 2-photon optical pumping. The effect of 2-photon absorption of a strong field in a gas medium is based on the equations of the density matrix for molecular gases. The distributed feedback "matrix" is created by interference of 2 pumping beams. References 5: 3 Russian, 2 Western.

USSR

UDC 621.378.35

CALCULATION OF THE DISTRIBUTION OF CURRENT CARRIER CONCENTRATION IN
INJECTION-TYPE STRIP LASERS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA SERIYA 3, FIZIKA ASTRONOMIYA in
Russian Vol 18, No 2, Mar/Apr 77 pp 76-78 manuscript received 20 Jun 76

LOGGINOV, A. S. and SOLOV'YEV, V. YE., Department of Vibration Physics

[Abstract] Earlier works on limitation of the optical field of the pn junction in strip lasers have a number of shortcomings: they fail to consider joint diffusion of electrons and holes or the influence of charge carrier concentration on current distribution. Finally, the model of the cross section of the strip laser is applicable only for contact and planar lasers, not for lasers with mesa structure or lasers manufactured by proton bombardment. This article studies a broader model. The active area is separated by a p type layer from the contact. In this layer an area of elevated concentration is created, the current in which is equal to 0. A system of equations is produced describing the distribution of concentrations of charge carriers in the active layer. The self-consistent problem of distribution of charge carriers and current density of injection into the active layer of strip lasers of varying geometry is solved. Figures 3; Abstracts 9: 1 Russian, 8 Western.

USSR

UDC 535.3:621.378.3

A STUDY OF FIELD DISTRIBUTION AND THREE-DIMENSIONAL COHERENCE OF SUPER-RADIATION AT THE $\lambda = 3.39 \mu\text{m}$ TRANSITION IN AN He-Ne LASER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA SERIYA 3, FIZIKA ASTRONOMIYA in
Russian Vol 18, No 2, Mar/Apr 77 pp 43-47 manuscript received 9 Jul 76

KOROLEV, F. A., ODINTSOV, A. I. and SUSU KHALED (Syria), Department of Optics

[Abstract] An experimental study was done on the distribution of the field in the transverse cross section of a beam of superradiation on the $\lambda = 3.39 \mu\text{m}$ transition in a helium-neon laser with a discharge tube 10 mm in diameter and 4 m long in a mode far from saturation. It was found that channelization of the beam occurs in the active medium of the laser, as a result of which the transverse diameter of the beam is significantly less than the diameter of the tube, while the angular divergence of the beam approaches the diffraction limit. It is noted that in order for these effects to be observed it is essential that the active medium in the laser not be saturated. This will prevent constriction of the beam of superradiation both due to general reduction in the effective gain and due to a change in its radial profile. Figures 4; references 14: 9 Russian, 5 Western.

USSR

UDC 538.56:519.25

DISTRIBUTION OF PHOTO READOUTS OF INTENSITY-MODULATED LASER RADIATION

Tashkent IZVESTIYA AKADEMII NAUK UZBEKSKOY SSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1977 pp 86-87 manuscript received 14 Apr 76

UMAROV, G. YA., MIRZAYEV, AS. T., KHADZHIMUKHAMEDOV, KH. KH. and MIRZAYEV, AG. T., Tashkent State University imeni V. I. Lenin

[Abstract] A statistical study of intensity-modulated laser radiation was done at three modulation frequencies and percentage modulation ranging from 50 to 100%. Measurements were made with a model FEU-30 photo detector, an LG-149 helium-neon laser ($\lambda = 0.6328 \mu\text{m}$) served as the single-frequency source, and periodic rectangular pulse signals were transmitted to a model ML-4 standard modulator. The modulation index was varied by regulating the a.c. voltage at the input of the modulator crystal and simultaneously measured by photon count throughout the experiment. The statistics are based on a large number of photo readouts and the data agree closely with theory, except some discrepancies attributable to the finite time of counter response. The Poisson distribution curve widens as 100% modulation is approached but, with longer periods of the modulating signal, the peak on the distribution curve flattens and shifts to the right. The results of this experiment may be useful for detection of modulated laser signals submerged in noise.

Figures 1; references 5: 2 Russian, 3 Western.

USSR

UDC 535.215

NONLINEAR PHOTOELECTRIC EFFECT IN METALS DUE TO LASER ACTION

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 122, No 2, Jun 77 pp 185-222

ANISIMOV, S. I., Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences, BENDERSKIY, V. A., Institute of Chemical Physics, USSR Academy of Sciences, Chernogolovka (Moscow Oblast), and FARKAS, GY., Central Institute of Physical Research, Hungarian Academy of Sciences, Budapest

[Abstract] Recent developments in research concerning the photoelectric effect, essentially the surface effect, in metals due to laser action are summarized here. Experimental studies covered in this report include those of nonlinear photoemission from metals into vacuum due to nanosecond laser pulses and due to picosecond laser pulses, also nonlinear photoemission from metals into electrolytes. In each case the electron energy spectra, the photocurrent-polarization characteristics, the photocurrent-luminance characteristics, and the photocurrent-time characteristics have been measured. In addition, the theories of nonlinear photoemission are overviewed here, namely the perturbation theory from the phenomenological standpoint, with its application to and limitations in the case of high

light intensities as well as with the effect of cathode heating, and the theory of threshold phenomena particularly applicable to photoemission from metals into electrolytes. The report concludes with general comments about the nonlinear three-dimensional (volume) photoelectric effect. Figures 34; tables 3; references 83: 27 Russian, 2 Hungarian, 54 Western.

USSR

A DISPOSABLE FLASH BULB FOR PORTABLE LASERS

Moscow PRIRODA in Russian No 11, Nov 77 p 151

MAKHROV, YE. P., CHEREPOV, N. I., and YAZEV, I. I.

[Abstract] Various flash lamps are often used for optical pumping of pulse lasers and usually the service life, i.e., the number of flashes before failure is their most important performance indicator. It appears feasible, however, to also use flashbulbs already used in photography and manufactured abroad at a rate of 10^9 annually for triggering a portable laser. A contributing factor here is the close overlap of the flashbulb emission spectrum and the absorption spectrum of active laser elements (neodymium-activated YAG crystal or glass). Essentially such a flashbulb consists of an incandescent zirconium foil uniformly filling a glass bulb and ignited by a hot tungsten wire. A translucent protective coating around the bulb prevents the shattered glass from scattering. Such a flashbulb is used in a laser measuring 40x40x120 mm and weighing 300 g. It is energized from a "Kron" battery through a 200 μ F capacitor. It emits an energy of 200 J for a laser emitting pulses of 1.2 J at $\lambda = 1.06 \mu\text{m}$.

USSR

UDC 621.378.35

INTERACTION BETWEEN AND SPECTRAL DISTRIBUTION OF TRANSVERSE MODES IN GaAs STRIPLINE LASERS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3, FIZIKA I ASTRONOMIYA in Russian Vol 18, No 4, Jul/Aug 77 pp 32-37 manuscript received 10 Nov 76

LOGGINOV, A. S. and SOLOV'YEV, V. YE., Chair of Oscillation Physics, Moscow University

[Abstract] A relation between the spectral distribution of transverse modes and the self-modulation of laser radiation has been established experimentally in lasers with a stripline geometry and a twin heterostructure. The GaAs injection lasers for this study were of the junction type with a 10 μm wide

contact zone or produced by bombardment with protons leaving a 25 μm wide untouched zone, all specimens 0.5 μm thick. Both the near-field dynamics are the integral (spectral-spatial) radiation distribution were recorded. The experimental data and a calculated estimate of the distance between peaks of oscillation envelopes, due to different excitation thresholds, indicate that interaction between different transverse modes could be one mechanism of this self-modulation in semiconductor stripline lasers. Figures 4; references 16: 6 Russian, 10 Western.

USSR

UDC 533.951.537.525

OSCILLATIONS OF A GAS LASER DISCHARGE (A SURVEY)

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2085-2119 manuscript received 24 Jun 76

PRIVALOV, V. YE., All-Union Scientific Research Institute of Metrology, Leningrad

[Abstract] Research is reviewed on the basic properties of regular oscillations in a gas laser discharge. Elements of the theory are reviewed as well as the experimental data that verify the theory; particular emphasis is given to He-Ne lasers. An interpretation is given of the reactive oscillations due to the tank circuit formed by the inductances inherent in the electric circuit and the negative resistance of the system due to the falling section of the current-voltage characteristic, leading to self-oscillations. Also examined are localized oscillations of various types: oscillations of the double layer, cathode oscillations and anode oscillations. A detailed presentation is given on what is known about striae, i.e. ionization waves caused by non-coincidence of the maxima of concentration and oscillation. The dynamic properties of a gas discharge are discussed, and an investigation is made of the influence that discharge oscillations have on gas laser emission, including reactive oscillations, localized oscillations, stria, noises in a gas discharge, influence of the fluctuations in discharge current, and the influence of oscillations on the frequency characteristics of lasers. A separate study is presented on the influence that discharge oscillations have on the emission parameters of a gas ring laser. Methods of controlling oscillations in a gas laser discharge are considered, including elimination of reactive oscillations, localized oscillations and striae and the interaction of oscillations in a tube with two discharge gaps. The methods that have been developed for dealing with discharge fluctuations have improved measurement accuracy in many instances, making it feasible to use gas discharge lasers as elements of precision measurement facilities and standards. Figures 23; references 174: 124 Russian, 1 Polish, 49 Western.

USSR

UDC 535.211:621.378.52

PLASMA FORMATION WHEN CO₂ LASER EMISSION PASSES THROUGH TRANSPARENT DIELECTRICS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2120-2124
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GOLUBEV, V. S., KISELEVSKIY, L. I. and SNOPKO, V. N., Institute of Physics,
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[Abstract] An investigation is made of the passage of sub-breakdown and trans-breakdown fluxes of CO₂ laser radiation through optical crystals of sodium chloride and potassium bromide. Interaction between the laser radiation and the dielectric was studied as the specimen was moved away from the lens toward the focal plane. At a certain distance from the lens, a plasma region begins to form with bright fluorescence. When the beam intensity reaches 7 MW/cm², cracks appear in the crystal in the direction of the cleavage planes. As a result of absorption losses in the plasma formed, the pulse energy transmitted through the crystal amounts to about 30% of the energy that is transmitted in the absence of a plasma. High-speed photographs show that the plasma starts on the surface of the specimen and expands as a hemisphere. When the beam intensity reaches 8 MW/cm², the plasma appears on both sides of the plate, showing that the threshold flux densities are about the same on both surfaces. This causes stronger absorption, and the transmitted energy is reduced to 13-15%. Estimates based on the spectrum of the plasma formations give a plasma temperature of about 25,000 K. When beam intensity reaches 12 MW/cm² (the surface of the plate facing the laser is at the focus), the plasma formation appears only on the side facing the laser, and is stretched out in the direction of the laser. The tip of the elongated plasma cloud propagates five times faster than the spread toward the sides. The emission spectrum in this case is almost totally due to oxygen and nitrogen ions, with almost no sign of the spectral lines of the crystal material. An examination is made of the kinetics of optical breakdown of air close to the dielectric. Figures 3; references 13: 10 Russian, 3 Western.

USSR

UDC 621.375.826:541.127

ANALYTICAL THEORY OF A STEADY-STATE CO LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2125-2134
manuscript received 11 Jun 76, after revision 21 Apr 77

NAPARTOVICH, A. P., NOVOBRANTSEV, I. V. and STAROSTIN, A. N., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov, Moscow

[Abstract] An approximate analytical theory is proposed for a steady-state CO laser. Simple explicit expressions are derived for the efficiency and the emission spectrum as a function of pumping, temperature, gas composition and

type of cavity. The proposed theory is compared with experiment and with the results of numerical analysis. It is shown that the formulas derived can be used for estimates of energy characteristics and investigation of parametric dependences (on temperature, pressure, gas composition, cavity storage factor) of steady-state lasers with accuracy at least as good as the results of detailed numerical calculations. It is concluded that the characteristic power depends not only on the parameters of the medium, but also on the degree of excitation of carbon monoxide molecules. This distinguishes the kinetics of the CO laser from most conventional systems, and is a consequence of the specific mechanism of inversion due to V-V exchange (self-pumping). The results of this study show that any formulas for saturation intensity that do not contain pumping power or resonator characteristics are incorrect in a strict sense, and can serve as estimates only in the narrow region for which they are derived. The authors thank I. V. Kochetov and V. G. Pevgov who did the calculations used in evaluating the accuracy of the theory constructed in this work. Figures 2; references 21: 6 Russian, 15 Western.

USSR

UDC 621.378.325

A FLOW-THROUGH IODIDE LASER WITH CONTINUOUS PUMPING

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2150-2156 manuscript received 24 Nov 76

ANDREYEVA, T. L., BIRICH, G. N., SOBEL'MAN, I. I., SOROKIN, V. N., and STRUK, I. I., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] Experimental studies are done on a cw iodide laser pumped by a high-pressure PRK-7 mercury lamp. Measurements of the emission intensity of the pumping lamp showed that an increase in the supply power from 1 to 4 kW showed an increase in intensity by a factor of about 4.5 without any appreciable change in efficiency. Three working fluids were tested: CF_3I , $(CF_3)_2AsI$ and $(CF_3)_3CI$. The final choice was $(CF_3)_3CI$, mainly because a single batch gives a large number of flashes without any appreciable drop in the energy of stimulated emission. The model that was studied was comparatively simple, and was designed for operation for approximately 1 s. The determining factor in the duration of operation was the amount of working fluid, as experiments with a closed cycle were not done. Estimates are made of the power and efficiency of an optimized cw laser based on the studies of this model. It is concluded that optimum utilization of the properties of the working substance and pumping radiation should give lasers with power far exceeding 1 W. The approximate parameters of a 1 kW laser: length of the working cell 1 m, diameter 6 cm, 4 PRK-7 lamps every 17 cm of length (24 lamps in all), power input to the lamps about 100 kW, gasdynamic flowrate of working fluid about 100 g/s or less. In a closed cycle the loss of working fluid would be of the order of 1 gram per hour or less. The authors thank N. G. Basov for interest in the work and discussion, and V. S. Zuyev and L. D. Mikheyev for calling their attention to a number of specific properties of $(CF_3)_3CI$. Figures 5; references 10: 8 Russian, 2 Western.

USSR

UDC 551.576.001+551.508.9

EMISSION OF IONS WHEN DROPS OF ELECTROLYTES ARE HEATED BY LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2182-2188 manuscript received 7 Dec 76

SAVCHENKO, A. V., SVIRKUNOV, P. N. and SMIRNOV, V. V., Institute of Experimental Meteorology, Obninsk

[Abstract] An experimental study is done on ion emission from electrolyte droplets exposed to a CO₂ laser. The technique is based on studying the changes of electric structure of a liquid aerosol formed by heterogeneous condensation on sodium chloride particles. The laser beam was fed into one end of a tube while the aerosol was being injected at the other end, and provisions were made for taking samples from the center of the tube for analysis of the structure of the space charge of the air with the heated aerosol. The space charge spectrometer is described. It is shown that the principles underlying emission of hydrated ions when droplets of electrolytes are heated by laser can be described on the basis of diffusion theory with consideration of a number of model concepts on electrolyte structure. This heating mechanism may produce an ion concentration of up to 10⁴-10⁶ cm⁻³. The sign and magnitude of the charge formed on the droplets depends on the ratio between cation and anion hydration energies. Figures 3; references 20: 15 Russian, 5 Western.

USSR

UDC 535.341

TWO-PHOTON ABSORPTION OF ULTRASHORT PULSES IN A GAS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2189-2195 manuscript received 9 Dec 76

BAKLANOV, YE. V. and CHEBOTAYEV, V. P., Institute of Physics of Semiconductors, Siberian Department of the Academy of Sciences USSR, Novosibirsk

[Abstract] A new technique is proposed for producing narrow resonances in two-photon absorption by using a continuous sequence of ultrashort pulses in a gas. These pulse trains are produced by mode locking of cw lasers with a broad amplification line. As opposed pulse trains interact, resonances arise when the sum of the frequencies of the two locked modes coincides with the transition frequency. The width of these resonances is determined by the width of the two-photon transition rather than by pulse duration. The intensity of the resonance is the same as in the case of a single-frequency mode of the same power. Thus it is feasible to observe resonances on the 1S-2S transition of the hydrogen atom since it is easier to get the ultrashort-pulse mode than a single-frequency mode of the same power. The authors thank B. Ya. Dubetskiy and N. G. Nikulin for discussion of the work. Figure 1; references 5: 3 Russian, 2 Western.

USSR

UDC 621.378.33

AN ELECTROIONIZATION LASER BASED ON A CO₂-N₂-H₂ MIXTURE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2216-2224
manuscript received 21 Jan 77

BASOV, N. G., DANILYCHEV, V. A., IONIN, A. A., KAZAKEVICH, V. S., KLEMENTOV, A. D., KOVSH, I. B., POLETAYEV, N. L., SOBOLEV, V. A. and KHOLODENKOV, L. YE., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] An experimental study is done on the feasibility of substituting hydrogen for helium in a CO₂ electroionization laser. Short-pulse and long-pulse modes were studied on separate installations; the parameters of the two units are given. Energy and time characteristics were studied for laser emission on a number of CO₂-N₂ mixtures, as well as the parameters of a semi-self-maintained discharge with different concentrations of hydrogen in the mixture. Measurements were also made for the corresponding mixtures containing about 50% helium. It is found that in the short-pulse mode the hydrogen-containing mixtures are markedly superior to those with helium in power output without any sacrifice of efficiency. In the quasi-steady state with given parameters of the source of ionization, the working mixtures in the electroionization laser with 1-3% hydrogen had the same output parameters as when helium was used. This is important as mixtures with hydrogen are hundreds of times less expensive. The dependence of the output parameters of electroionization lasers on the hydrogen concentration in the working mixture is determined solely by the corresponding change in lifetime of the laser levels and pumping efficiency, rather than by any improvement in discharge characteristics, as is the case for TEA lasers. The authors thank A. N. Lobanov and B. M. Urin for discussing the results. Figures 6; references 16: 7 Russian, 9 Western.

USSR

UDC 621.378.33

THEORETICAL STUDY OF A CW CHEMICAL HF LASER WITH TELESCOPIC CAVITY

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2234-2245
manuscript received 15 Nov 76

VIRNIK, YA. Z., KRUTOVA, V. G., MASHCHENKO, A. I., ORAYEVSKIY, A. N., STEPANOV, A. A. and SHCHEGLOV, V. A., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] Stimulated emission of an HF laser of diffusion type with a cylindrical telescopic cavity is numerically studied, using a simplified approach to describe mixing that is based on a flame-front model and gives a first approximation without the use of Navier-Stokes equations. The telescopic cavity is calculated in the geometric optics approximation with

the use of an iteration process. The results of the theoretical analysis show that with appropriate choice of parameters, telescopic cavities can be used successfully in cw HF lasers of diffusion type. Moreover, the use of such cavities reduces the loads on the mirrors with a comparatively slight reduction in efficiency. It is pointed out that spherical rather than cylindrical telescopic cavities are used in practice; however, the proposed approach can be extended to the three-dimensional case, and the qualitative principles should remain in effect. The authors thank Ye. P. Markin and A. K. Piskunov for constructive criticism. Figures 8; references 23: 14 Russian, 9 Western.

USSR

UDC 531.715.1

LASER INTERFEROMETERS WITH PATH DIFFERENCE UP TO 1 km

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2260-2262 manuscript received 24 Feb 77

ALESHIN, V. A. and DUBROV, M. N., Institute of Radio Engineering and Electronics, Academy of Sciences USSR, Moscow

[Abstract] Laser interferometers were studied over a distance of up to 1 km based on an underground mirror beam guide to determine the instability of optical length. Test results are given for two interferometers, showing the theoretical feasibility of using air-filled light guides isolated from the atmosphere in schemes of uneven-arm Michelson interferometers for precision measurements of deformations of the earth's surface. In one of the interferometers one of the beams is coupled into the beam guide line (a ring 1090 m long) and when it is combined with the reference beam an interference pattern is formed at the output. The other interferometer is in the form of an asymmetric Michelson arrangement, the long arm being a hermetically sealed section of beam guide tubing 93 m long (the length of the short arm is 0.2 m and the path difference is 186 m). The system used for recording the motion of the interference pattern is described. The results of the studies show that hermetic sealing of the beam guide channel reduces the long-term instability of air-filled interferometers by more than an order of magnitude by eliminating changes in the index of refraction of the medium. Figures 2; references 9 Russian.

USSR

UDC 621.039.66+621.375.826

DETERMINATION OF THE ELECTRON DENSITY PROFILE IN A LASER PLASMA FROM STARK BROADENING OF SPECTRAL LINES IN THE FAR VACUUM ULTRAVIOLET REGION OF THE SPECTRUM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2262-2265
manuscript received 11 Mar 77

RAGOZIN, YE. N., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] Stark broadening is measured to determine the electron density N_e as a function of distance to the target in the 0-250 μm range with focusing of the laser beam to a spot 800 μm in diameter with average flux density q of about $8 \cdot 10^{11} \text{ W/cm}^2$. The electron density profile was determined from Stark transitions 3-2 (H_α , $\lambda = 182.17 \text{ \AA}$) and 4-2 (H_β , $\lambda = 134.95 \text{ \AA}$) of the CVI ion. The results show that a plasma with zero gradient in electron concentration could be produced in a limited region of space. The authors thanks I. I. Sobel'man, G. V. Peregudov and Ye. A. Yukov for discussion and constructive criticism, V. A. Chirkov and A. A. Ilyukhin for cooperation in making the spectrograms, and M. R. Shpol'skiy and N. V. Uvarov for providing the UF-4 photographic film. Figures 3; references 7: 5 Russian, 2 Western.

USSR

UDC 535.312

REFLECTION OF EMISSION FROM THE PLASMA MIRROR OF A CO_2 ELECTROIONIZATION LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2268-2271
manuscript received 22 Apr 77

BASOV, N. G., BOYKO, V. A., DANILYCHEV, V. A., ZVORYKIN, V. D., KHOLIN, I. V. and CHUGUNOV, A. YU., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] The authors investigate reflection of laser emission from the plasma mirror in a simple CO_2 electroionization laser with a solid target as one of the mirrors in the optical cavity. The other mirror was flat with 100% reflection, the cavity was 13.5 m long, and the target was located in the focal plane of a focusing mirror and was held in a vacuum chamber. The laser pulse consisted of a signal 100 ns in duration followed by a train of nanosecond pulses separated by a time equal to that of a round trip of a photon through the resonator cavity. It was found that the coefficient of reflection of laser radiation from the plasma in a solid angle of 2π radians in the hemisphere turned toward the mirror is about 45% for the long pulse (100 ns) and about 65% for the train of nanosecond spikes. The difference is due to backscattering. The authors thank B. Ya. Zel'dovich and V. V. Ragul'skiy for constructive criticism. Figures 5; references 11: 4 Russian, 7 Western.

USSR

UDC 535.339.04

MEASUREMENT OF THE CROSS SECTION OF PHOTOIONIZATION OF A LITHIUM ATOM FROM LEVEL 2P

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2275-2276 manuscript received 5 May 77

KARLOV, N. V., KRYNETSKIY, B. B. and STEL'MAKH, O. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR

[Abstract] The authors measure the cross section of photoionization in a beam of lithium atoms from level 2P on a wavelength of $\lambda = 337.1$ nm by a technique involving determination of the number of ions formed as a result of photoionization. The source of resonant emission ($\lambda = 670.784$ nm) was a rhodamine 640 dye laser with lamp pumping ($\Delta\lambda = 0.01$ nm). The dispersing elements were a birefringent filter and a Fabry-Perot etalon. The source of emission on $\lambda = 337.1$ nm was a nitrogen laser synchronized with the dye laser. Ion recording was by a system of electron lenses with extraction of the ions into a vacuum electron multiplier. The beam of lithium atoms was produced by vaporizing metallic lithium, and had a density of $7 \cdot 10^{10} \text{ cm}^{-3}$. The cross section of photoionization from level 2P was found to be $(1 \pm 0.3) \cdot 10^{-17} \text{ cm}^2$. Figures 3; references 3: 2 Russian, 1 Western.

Magnetohydrodynamics

USSR

UDC 538.4

MHD CONDUCTION CHOCKE WITH AN AXISYMMETRIC FLOWTHROUGH CHANNEL

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 131-135
manuscript received 14 Jan 77

GORBUNOV, L. A.

[Abstract] An MHD conduction choke is described which consists of a circular pipe with a series of flat annular expansions, in the gap between magnet poles. Electric current is passed along the pipe axis and the orientation of the magnetic field does not matter. The performance of such a choke is determined from the total pressure balance, each component of the pressure drop having been evaluated experimentally as well as theoretically. A critical factor is the pressure loss due to interaction between the main stream and eddies. Calculations of this pressure loss on the basis of the law of momentum conservation agree closely with experimental data. The distributions of electric potential and current have been calculated by the method of finite differences. Figures 5; references: 7 Russian.

USSR

UDC 538.4:621.791.753.9

NUMERICAL METHOD OF DETERMINING THE FREE SURFACE OF DROPLETS OF THE ELECTRODE METAL DURING ITS TRANSPORT THROUGH THE MAGNETIC FIELD OF A WELDING ARC

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 121-126 manuscript received 24 Jan 77

KOLESNICHENKO, A. F., VOROPAY, N. M., LUN'KOVA, O. N., and TOKARCHUK, V. N.

[Abstract] The free surface of molten metal in a welding arc is considered in the quasistationary state, where each element departs infinitesimally from its equilibrium. Elementary body and surface forces are taken into account which result from interaction of the current through channel and arc with the intrinsic magnetic field. These forces and, therefore, also the shape and the size of the free surface of metal droplets are determined by the arc current, the voltage, and the electrical conductivity of the shielding atmosphere. The analysis is based on a balance between the resultant of all external pressures acting on the surface and the surface tension of the liquid. The calculations are based on axial symmetry, uniform current density, an effective arc diameter smaller than the droplet diameter, very weak electrostatic forces, and a very small velocity increment due to the presence of gas and liquid at the electrode-droplet interface. The equations describing the free surface, written in polar coordinates, have been solved numerically with the aid of a digital computer. The results are shown pertaining to typical welding conditions in monatomic gases, with an apparent flattening of droplets. No such flattening has been noted in

reality, mainly because the arc pressures usually pull a droplet away from the symmetry axis. The validity of this simulation method is limited, therefore, to welding with a moderate constriction of the arc and the droplet diameter not larger than the electrode diameter. Figures 2; references: 4 Russian.

USSR

UDC 621.313.333:538.4

EFFECT OF CHANNEL GEOMETRY ON THE BASIC PERFORMANCE CHARACTERISTICS OF A LIQUID-METAL MHD-PUMP WITH A CLOSING BUSBAR

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 116-120
manuscript received 26 Oct 76

BARYNIN, M. I. and CHIZHEVSKIY, V. G.

[Abstract] Fundamental theoretical relations are derived for calculating, approximately, the parameters of the electromagnetic field in a liquid-metal MHD pump and the basic performance characteristics of such a pump. A transformer-type pump with a variable-section channel and a high-conductance busbar closing at the exit end is considered here. The calculations are based on Ampere's law, Ohm's law, and the law of induction. The resulting expressions for the specific pressure head and the specific internal efficiency indicate that both can be increased by a proper variation of the width and the height over the channel length. Figures 3; references: 2 Russian.

USSR

UDC 538.4

INTERACTION BETWEEN A LAYER OF ELECTRICALLY CONDUCTING LIQUID AND A MAGNETIC FIELD IN A SHIELDED CHANNEL

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 105-108
manuscript received 7 Feb 77

SYUSYUKIN, A. I.

[Abstract] An experimental study was made to determine the optimum conditions for inducing an electric current in a layer of liquid metal moving in a stationary magnetic field and, particularly, the effect of a shield around this layer. The test channel included a coaxial segment with magnets inside and outside. The cylindrical shield was made of solid copper with a wall thickness designed to make its volume equivalent to the copper volume of shorted coils. In the shielded channel in contrast to the unshielded case the strength of

the induced magnetic field was found to first increase slowly and then decrease rapidly along the channel, with the shielding factor decreasing from 1.0 at the entrance to 0.14 or near zero (complete shielding) at the exit. A shield thus changes the process of current excitation in a moving layer, by weakening the magnetic field induced in this layer so that the coupling with external electric circuit also becomes weaker. Figures 5; references: 5 Russian.

USSR

UDC 621.313.333:538.4

LOCAL FLOW CHARACTERISTICS IN THE CHANNEL OF AN MHD INDUCTION MACHINE AT HIGH VALUES OF THE ELECTROMAGNETIC INTERACTION PARAMETER

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 99-104 manuscript received 19 Sep 76

VALDMANE, R. A., KRISHBERG, R. A., LIELPETER, YA. YA., MIKRUJKOV, CH. K., and ULMANIS, L. YA.

[Abstract] An experimental study was made to determine the local flow characteristics of a model ENP-20 plane MHD induction pump operating with a liquid-sodium feed system. The tests were performed under conditions corresponding to values of the electromagnetic interaction parameter within the 4-4.5 range. Velocity profiles, without and with a magnetic field, as well as profiles of the magnetic induction across the channel width were measured at zero slip and at a slip varying over the 0.4-1.4 range. Reverse flow was found to develop along the channel axis at a slip of 0.7 and then along the channel walls at higher slips. Velocity profiles were also calculated, together with profiles of the electromagnetic pressure, on the basis of the Maxwell differential equation for current density and its numerical solution (the channel walls assumed to be electrically nonconducting). Noteworthy is the similarity between both. Slight differences between measured and calculated profiles are attributable to adhesion between liquid metal and channel walls as well as to friction between liquid layers, which have not been accounted for in the calculations. Figures 7; references: 6 Russian.

USSR

UDC 538.4

MHD-FLOW IN A PLANE LIQUID-METAL LAYER CARRYING AN ELECTRIC CURRENT

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 95-98
manuscript received 18 Feb 77

SHARAMKIN, V. I.

[Abstract] When a plane layer of liquid metal with all three dimensions variable carries an electric current in a magnetic field, then the generally vortical electromagnetic force is balanced by hydrodynamic forces only and a complex flow pattern results. Experiments with a partially constricted mercury layer have shown that the normal components of the curl of the electromagnetic force decisively affect the flow pattern. Experiments with a rectangular steel bar variously positioned inside or at the surface of a mercury layer, distorting both the field distribution and the current distribution, have yielded results which can be generalized into a relation based on proportionality between the angular velocity of a vortex and the magnitude of the current, with the former further expressed in terms of the MHD-interaction parameter and the Reynolds number. It has also been possible to establish, by photographic methods, a relation between current spreading and development of the main stream passing a barrier. The results of this study indicate the important role of MHD flow in mass and heat transfer and thus in the performance of industrial induction furnaces.

Figures 5; references 4: 3 Russian, 1 Western.

USSR

UDC 538.4

LAMINAR FLOW OF AN ELECTRICALLY CONDUCTING LIQUID BETWEEN COAXIAL CYLINDERS
IN A TRAVELING MAGNETIC FIELD

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 84-88 manuscript
received 26 Nov 76

KAMIYAMA, S. and KAVAI, YA.

[Abstract] The laminar flow of an electrically conducting incompressible fluid between two coaxial cylinders in a traveling magnetic field is analyzed on the basis of the fundamental field and flow equations. The effect of the inner core material is determined, by considering first a nonmagnetic dielectric material and then an electrically conducting material with an infinitely high magnetic permeability. Also the effects that two geometric parameters, namely the ratio of inside radius to outside radius and the ratio of outside radius to polar pitch, have on the average velocity profile and on the efficiency of an ideal MHD induction machine are analyzed. These characteristics have been evaluated numerically for a generator operating at a slip $s = -0.6$ and for a

pump operating at a slip $s = 0.6$, indicating an appreciable deceleration in the former and acceleration in the latter in the vicinity of a ferromagnetic core. Figures 4; references 6: 5 Russian, 1 Western.

USSR

UDC 538.4

STATIONARY INSTABILITY OF AXISYMMETRIC FLOW OF A LIQUID IN A ROTATING MAGNETIC FIELD

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 67-76 manuscript received 26 Aug 76; after revision, 29 Mar 77

KAPUSTA, A. B. and ZIBOL'D, A. F.

[Abstract] The stability of a primary azimuthal flow, with respect to stationary axisymmetries three-dimensional perturbations due to a rotating magnetic field, is considered in the case of low values of the Reynolds number and the Hartmann number. The analysis takes into account the deformation of the primary velocity profile due to changes in these dimensionless numbers as well as the interaction between secondary flow and primary magnetic field. The problem is formulated as one of linear MHD stability, in terms of the fundamental MHD equations relating the velocity vector to the induction vector in a viscous incompressible fluid and the equations of axisymmetric perturbations. The latter are solved by the Galerkin method and, with the aid of a digital computer, the critical values of the instability parameters have been evaluated numerically so that flow field structure could be plotted. Figures 3; references 6: 3 Russian, 1 German, 2 Western.

USSR

UDC 538.4

STEADY-STATE TURBULENT FLOW OF AN ELECTRICALLY CONDUCTING LIQUID IN A LONGITUDINAL MAGNETIC FIELD WITH VOLUME HEATING. PART 1: ANALYTICAL STUDY OF THE FLOW WITHIN THE BOUNDARY LAYER

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 51-56 manuscript received 25 Oct 76

BORTSAYKIN, S. M. and LEVITAN, YU. S.

[Abstract] A theoretical study is made of the turbulent flow of an electrically conducting liquid through a cylindrical channel in a longitudinal magnetic field under conditions of heating. The equations of such a flow are solved for the steady-state condition, with the flow parameters being functions

of the radial coordinate only and the axial pressure gradient held constant. The dynamic viscosity and the thermal conductivity are determined according to the Prandtl hypothesis. The solution to the resulting system of integro-differential equations, with appropriate boundary conditions, is applied to the profiles of velocity and temperature across the boundary layer. Furthermore, the turbulence components of frictional stress and thermal flux within the boundary layer are calculated on the basis of conventional relations as well as special empirical relations involving the Reynolds number, the Hartmann number, and their ratio. Figures 1; references 6: 3 Russian, 1 German, 2 Western.

USSR

UDC 531.16:538.4

STABILITY OF THE MOTION OF A PARTICLE SUSPENDED IN AN MHD STREAM

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 40-46 manuscript received 11 Oct 76

SHVARTS, I. A.

[Abstract] The motion of a solid particle in a laminar stream of an electrically conducting liquid in a transverse magnetic field is analyzed, for the purpose of determining the stability of such a motion at low values of the magnetic Reynolds number. The particle is assumed to be nonconducting and nonmagnetic so that the magnetic field does not act on it directly. Two mechanical forces are acting on the particle, namely viscous drag and Zhukovskiy lift, with gravity and buoyance balancing each other out. The hydrodynamic equations of perturbed motion are first solved, according to the Lyapunov principle, for a spherical particle moving along a streamline in a plane-parallel channel. A laminar MHD stream in a Couette channel is considered next, especially the behavior of a particle within the Hartmann layer. The relations yielding the critical Reynolds number can serve as a basis for analyzing the flow stability in more complex configurations. Figures 2; references 8: 7 Russian, 1 Western.

USSR

UDC 538.221:538.4

EXPERIMENTAL STUDY CONCERNING THE KINETICS OF MAGNETIC BIREFRINGENCE AND DICHROISM IN A DILUTE MAGNETIC FLUID

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 29-33 manuscript received 25 Feb 77

MAYOROV, M. M.

[Abstract] An external magnetic field induces optical anisotropy in a colloidal solution. An experimental study was made to determine the transient characteristic of this optical anisotropy after a sudden removal of the external magnetic field. The test apparatus included a monochromatic light source, a polarizer, a test cell with a specimen of magnetic fluid, an analyzer, an electromagnet, and a photomultiplier as part of the measuring system. The magnetic field was oriented at 45° to the polarization plane and 90° to the direction of the incident light beam. The electromagnet and the test cell were placed inside a thermostat. The electromagnet, energized from a square-wave generator, supplied pulses of $1.6 \cdot 10^5$ A/m amplitude and 10 μ s duration (5 μ s decay). The pulses were shaped so as to allow the optical relaxation process to be independent of the time characteristics of the magnetic field, thus ensuring a state of equilibrium prior to application of the external magnetic field and a return to isotropy in the absence of a magnetic field. The results of this experiment reveal a proportionality between the relaxation time of optical anisotropy in a magnetic fluid and the rotational diffusion (Brownian motion) time of its colloidal particles. A comparison with the calculated curve of optical anisotropy attenuation indicates a closer agreement with the nearest-order model than with the orientational model, especially if Neel relaxation is accounted for in the latter. Figures 6; references 8: 3 Russian, 5 Western.

USSR

UDC 538.4+538.114

INSTABILITY OF A THIN LAYER OF A MAGNETIZABLE FLUID WITH TWO FREE SURFACES

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 23-28 manuscript received 18 Feb 77

BASHTOVOY, V. G.

[Abstract] A stationary thin plane layer of magnetizable fluid with two free surfaces is considered in a uniform transverse magnetic field. The stability of such a layer is analyzed in the linear approximation, on the basis of which a dispersion equation for surface waves is obtained and the instability criteria are derived. Unlike in the case of a thick fluid layer, the instability criteria for a thin fluid layer depend on the differences of densities and differences of magnetization between the fluid and the two bounding media, especially when one of the latter becomes a solid. References 5: 3 Russian, 2 Western.

USSR

UDC 538.4

NONLINEAR HELICAL MHD INSTABILITY

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 3, Jul/Sep 77 pp 5-22 manuscript received 7 Feb 77

ZUYEVA, N. M. and SOLOV'YEV, L. S.

[Abstract] The development of helical instability in a plasma is analyzed on the basis of MHD equations for a gas inside a conducting cylinder, with initial perturbation of symmetry. The problem is treated from the standpoint of linear theory and the variational principle is used for calculating the energy balance, assuming a nondissipative isentropic process. The maximum instability energy is determined and, with the aid of appropriate kinematic models, the evolution of magnetic surfaces in the plasma is considered next. The system of MHD equations has been numerically solved by computer experiments, with the effect of finite electrical conductivity and magnetic viscosity also taken into account. Both large-scale and local perturbations are involved. Helical MHD instability develops in a cylindrical configuration when the Seidem criterion of local stability is not satisfied, but becomes stationary in a toroidal configuration when the more general Mercier criterion of stability is satisfied. Figures 8; references 29: 21 Russian, 8 Western.

USSR

UDC 533.92:621.039.61

MEASUREMENT OF THE PLASMA DENSITY IN A MULTIPLE-GAP ELECTROMAGNETIC TRAP

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22, No 10, Oct 77 pp 1741-1743 manuscript received 19 Jan 77; after revision, 21 Apr 77

LAVRENT'YEV, O. A., SAPPA, N. N., and SIDORKIN, V. A., Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov

[Abstract] The plasma density in an electromagnetic trap was determined by injecting a jet of neutral potassium along the trap axis and measuring the decrease in the jet intensity. The data agree closely with measurements of the plasma density on the basis of the number of ions leaving the trap after injection of electrons has been completed. In order to also determine the plasma retention volume in the trap, the Störmer surface of permissible electron motion was calculated with the aid of a digital computer. The results indicate that a multiple-gap electromagnetic trap is the most effective one, in terms of high plasma retention volume and high magnetic field gradient at the boundaries of this volume as well as in terms of radial focusing of particles and the most favorable ratio of retention volume to surface losses. Figures 2; references 7: 6 Russian, 1 Western.

USSR

UDC 533.951.7

EXCITATION OF REGULAR LARGE-AMPLITUDE OSCILLATIONS IN A NONLINEAR PLASMA
MODULATED BY AN ELECTRON BEAM

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22, No 10, Oct 77
pp 1733-1736 manuscript received 1 Dec 76; after revision, 8 Apr 77

KRASOVITSKIY, V. B. and KRYMSKIY, A. M., Rostov State University

[Abstract] The nonlinear mechanism of oscillation limiting by expulsion of plasma electrons from the region of peak high-frequency field intensity is analyzed here in the case where a low-density electron beam has been injected into a highly non-isothermal plasma, resulting in a Boltzmann equilibrium of the electrons with the high-frequency field and in a uniform distribution of the "cold" ions over the plasma volume. The fundamental equations of motion and continuity for beam and plasma electrons are solved, with the electrostatic field set up in the plasma and with the ponderomotive force acting on the electrons properly taken into account. The energy density of oscillations is calculated and the stability limit is established.

References: 3 Russian.

USSR

UDC 533.951.8

NONLINEAR WAVE AMPLIFICATION IN PLASMA-BEAM MEDIA

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22, No 10, Oct 77
pp 1731-1733 manuscript received 10 Mar 77

PAVLENKO, V. P., Institute of Nuclear Research, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] While wave amplification in a plasma by a penetrating low-density monoenergetic electron beam is always possible in principle, the feasibility of amplification as a result of nonlinear wave coupling is analyzed here theoretically on the basis of linear stability concepts. According to this theory, within such a fast electron beam much below resonance there exist space-charge waves including a slow one with negative energy. The interaction between this wave and waves with positive energy as well as the acoustic ion wave is calculated in the weak-coupling approximation and the conditions of an effective nonlinear interaction are determined. References: 3 Russian.

USSR

UDC 621.3.032.266

SYNTHESIS OF SYSTEMS FOR FORMING HELICAL ELECTRON BEAMS

Gor'kiy IZVESTIYA VUZOV, RADIOFIZIKA in Russian Vol 20, No 10, Oct 77 pp 1550-1560 manuscript received 30 Mar 76; after revision, 29 Nov 76

TSIMRING, SH. YE., Gor'kiy State University

[Abstract] A magnetron-injection gun for forming helical electron beams is synthesized on the basis of a comparatively simple model, namely an infinitely large planar diode in a uniform magnetic field oriented at some angle to the plane of the cathode. The internal field problem requires a simultaneous solution of the equations of motion, the field (Poisson) equation, and the continuity equation. The solution, in terms of the oscillation velocity, indicates that an electron beam can be made laminar inside the gun but turbulent within the interaction space. The external field problem is solved by analytic continuation and conformal mapping. The solution, in terms of trajectories and equipotential lines, is obtained by numerical integration and determines the geometry of the electrodes. This design method does not take into account space charge within the transition zone and cylindricity of the electrode surfaces but, if combined with trajectory analysis (which takes space charge into account), should be reliable and effective enough. Figures 7; tables 1; references 10: 8 Russian, 2 Western.

USSR

UDC 53.082.79+533.9.07

MEASURING THE SPATIAL DISTRIBUTIONS OF RESIDUAL GAS DENSITY AND OF ELECTRIC POTENTIAL IN A PLASMA

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5, Sep/Oct 77 pp 35-40 manuscript received 15 Oct 76

BOCHAROV, V. N., KUDRYAVTSEV, A. M., SOROKIN, A. F., and UL'YANOV, YU. N., Novosibirsk

[Abstract] A method is proposed for determining the concentration of neutral atoms and molecules in a plasma of hydrogen isotopes. A beam of fast hydrogen or deuterium ions is injected into the plasma transversely to the magnetic field which contains the latter. The beam parameters, namely its energy and current as well as cross section are known and have to be varied to match any particular plasma and field characteristics. The charge transfer with residual gas particles and the electric potential at the points of charge transfer are determined from measurements with a detector-analyzer and calculations of energy and momentum balance along the known beam trajectory. The magnetic field is nonuniform with an exponential radial profile and maximum intensity at the center of the order of $1.6 \cdot 10^5$ A/m. The electron

concentration, the electron temperature, and the initial gas concentration are also measured. The accuracy of this method depends on the experimental precision and on the reliability of handbook data on charge-transfer cross sections. It is also necessary to minimize the uncontrollable attenuation of the "primary" ion beam and of the "secondary" atom flux, as well as the scattering of the "primary" ion beam by fluctuations of the electric field. If the magnetic field changes upon plasma ignition, but remains axisymmetric, then both the vector potential of the magnetic field and the electric potential can be calculated from measurements made with ion beams of two different masses. Figures 5; tables 1; references 8: 2 Russian, 6 Western.

USSR

UDC 621.371.255

EFFECT OF A HIGH-FREQUENCY ELECTRIC FIELD ON THE DISPERSION OF SURFACE WAVES EXCITED BY AN ELECTRON BEAM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 5, Sep/Oct 77 pp 24-27 manuscript received 6 Sep 76

DEMCHENKO, V. V. and OMEL'CHENKO, A. YA., Khar'kov

[Abstract] A cold homogeneous and isotropic plasma of some given density is considered whose nonrelativistic electrons move relative to stationary ions at some given velocity in the direction of an external high-frequency electric field. The boundary between this plasma and vacuum is assumed to be rigid. The problem of excitation of surface waves is solved in two parts, one in the space domain (independent of the amplitude of the field intensity) and one in the time domain (parametric). The solution indicates that the high-frequency field does not significantly affect the mode in which a mono-energetic electron beam excites surface waves, only slightly expanding the range of wave vectors corresponding to unstable waves. The results thus suggest one possible method of stabilizing unstable surface waves.
References: 3 Russian.

Mechanics

USSR

UDC 531.55:521.1

STABILITY OF UNSTEADY MOTIONS OF A SPINNING AXISYMMETRIC VEHICLE

Moscow IZVESTIYA AKADEMII NAUK SSSR, MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep/Oct 77 pp 32-39 manuscript received 12 Mar 76

ZHERMOLENKO, V. N. and LOKSHIN, B. YA., Moscow

[Abstract] When a finned vehicle spins slowly about its symmetry axis, then its motion through a medium may become unsteady and characterized by the Magnus effect. The sufficient conditions for stability of such a motion are sought here in the case of a statically stable axisymmetric finned vehicle moving through air. The analysis is based first on the concept of absolute stability, with the equations of motion written in movable rectangular coordinates so that the center of mass remains at the origin and oscillates together with the symmetry axis but does not rotate. This reduces the problem to that of seeking the asymptotic stability of the trivial solution to the equations of perturbations, which constitute the homogeneous part of the equations of motion, with the convergence mode and the maximum oscillation amplitude still unknown. The concept of engineering stability is applied next and the sufficient conditions are found, in terms of upper estimates, under which the oscillation amplitude will not exceed a given finite limit during a finite time interval. Figures 1; references 14: 11 Russian, 3 Western.

USSR

UDC 62-50

MANIPULATOR TRACKING OF PROGRAMMED MOTION

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA, MATEMATIKA MEKHANIKA ASTRONOMIYA
in Russian Vol 13, No 3, Jul 77 pp 132-136 manuscript received 7 Oct 76

VORONETSKAYA, D. K. and FOMIN, V. N.

[Abstract] An earlier developed algorithm of adaptive control (see G. S. Aksenov, V. N. Fomin, "On the Problem of Adaptive Control of a Manipulator" in "Voprosy kibernetiki. Adaptivnye sistemy" [Problems of Cybernetics. Adaptive Systems], Moscow, "Nauka," 1976 pp 164-168] is modified here so as to make unnecessary the measurement of higher-order (second) time derivatives of the manipulator state variables. The validity of this new algorithm is based on a theorem of monotonic convergence, a corollary of finite convergence derived therefrom, and a lemma establishing the conditions under which it applies. References: 3 Russian.

Molecular Physics

USSR

UDC 535.34:541.15

EFFECTIVENESS OF TWO-STAGE PHOTOIONIZATION OF AROMATIC AND HETEROAROMATIC MOLECULES IN SOLUTIONS BY ULTRAVIOLET LASER RADIATION

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 27, No 10, Oct 77
pp 708-712 manuscript received 20 Sep 76

ABAKUMOV, G. A., PODOL'SKAYA, L. S., POLYAKOV, B. I., SIMONOV, A. P.,
FADEYEV, V. V., and FADEYEVA, N. A.

[Abstract] The effectiveness of photoionizing certain aromatic and heteroaromatic compounds in polar solvents such as ethanol or tetrahydrofuran by excitation with radiation pulses at the third harmonic (353 nm) and at the fourth harmonic (265 nm) of a neodymium laser has been determined experimentally. The results reveal that, within the range of low excitation density and concentrations within 10^{-4} - 10^{-3} mole/liter (sufficiently low to ensure complete absorption of the pumping radiation within the inter-electrode gap), the intensity of photoionization is a linear function of the photon flux density. They also reveal that this photoionization is a two-quantum process. The theoretical analysis of this process is based on assuming photoionization either only through the intermediate triplet level or only through the intermediate singlet level and then finding, in accordance with the linearly approximated kinetic equations, that the total number of solvated electrons or ions equals the sum of both. Figures 1; tables 1; references 12: 4 Russian, 8 Western.

USSR

UDC 535.37

SOME PATTERNS IN THE QUENCHING OF LUMINESCENCE OF URANYL NITRATES AND URANYL FLUORIDES

Minsk DOKLADY AKADEMII NAUK BELORUSSKOY SSR in Russian Vol 21, No 6, Jun 77
pp 518-520 manuscript received 24 Dec 76

ATRASHEVSKIY, YU. I., academician of the Academy of Sciences BSSR, SEVCHENKO, A.N., SKUTOV, I. K., and UMREYKO, D. S., Scientific Research Institute of Physical Problems, Belorussian State University imeni V. I. Lenin

[Abstract] Finding and understanding the mechanism by which the energy of electron excitation becomes degraded is one of the most relevant problems in the theory of luminescence, especially in the case of uranium compounds. Toward this end, the authors have experimentally established some governing principles. The relative quantum yield and the lifetime of molecules in the state of excitation were measured, after the spectral sensitivity of the specimens of fine-crystalline alkali (rubidium, cesium, ammonium, potassium) uranyl-nitrates and meromorphous (monomer, dimer, polymer) potassium uranyl fluorides had been calibrated against a model SI-6-100

tungsten lamp. According to the results, there is a correspondence between both luminescence parameters. This indicates that here interaction between a light quantum and a molecule or complex is accompanied by excitation of an electron shell with subsequent partial extinction of luminescence and partial energy de-activation by either conversion to heat or transfer to other parts of the complex and other molecules. Potassium complexes are characterized by the lowest luminescence quantum yield and the shortest luminescence lifetime in both series. On the other hand, compounds with an insular structure are characterized by the highest luminescence quantum yield and the longest luminescence lifetime, both decreasing with increasing polymerization level. Tables 1; references 15: 7 Russian, 8 Western.

Nuclear Physics

USSR

EFFECT OF TRANSITION STATES IN A FISSILE Th²³³ NUCLEUS ON THE KINETIC ENERGY OF FISSION PRODUCTS

Moscow YADERNAYA FIZIKA in Russian Vol 26, No 4, Oct 77 pp 691-694 manuscript received 1 Nov 76

D'YACHENKO, N. P., KUZ'MINOV, B. D., MITROFANOV, V. F., and SERGACHEV, A. I., Energy Physics Institute, Obninsk

[Abstract] The kinetic energy of nuclear fission products consists essentially of the Coulomb repulsion energy, very sensitive to the relative spacing of fission products at the instant of their appearance, also the translation energy associated with the descent of the nucleus from the barrier, and the collective energy of vibrational states within the barrier region. Separating these components is very difficult, but the effect of transition states can be estimated from the correlation between the mean kinetic energy of fission products and other characteristics of the fission process which reflect the properties of transition states. In an experimental study for this purpose, a Th²³³ nucleus was split with neutrons whose energy could be varied from 1.2 to 2.3 MeV in 50 keV steps (at a ± 50 keV resolution) and the mean kinetic energies of the fission products were measured with an apparatus of adequate sensitivity. As a reference value was taken 163.17 MeV, obtained with 2.37 MeV neutrons in an earlier study. The results have been subsequently corrected for emission of prompt fission neutrons and various energy losses within the system. The results indicate that changes in the kinetic energy of fission products could either characterize the energy of collective nucleus vibrations near the saddle point or be due to momentum variations within a splitting nucleus. Figures 1; tables 1; references 7: 3 Russian, 4 Western.

USSR

HOT-PLASMA STUDIES ON THE TOKAMAK-10

Moscow PRIRODA in Russian No 11, Nov 77 pp 72-79

STRELKOV, V. S., doctor of physical and mathematical sciences, Chief, Institute of Nuclear Energy imeni I. V. Kurchatov

[Abstract] The plasma on the Tokamak-10 is generated inside a toroidal chamber under a vacuum of 10^{-8} - 10^{-9} mm Hg upon injection of hydrogen or deuterium at 10^{-5} - 10^{-4} mm Hg as the working gas, around the core of a pulse transformer whose primary winding is energized from a capacitor bank. The plasma is also in the form of a torus and is heated by a high predominantly electron current flowing through it. This electric current also produces a magnetic field which retains charged particles within the plasma and thus improves the thermal insulation so as to prevent their direct contact with

the chamber walls. Another strong magnetic field parallel to the plasma current ensures stability of the plasma formation. The basic design parameters of the Tokamak-10 chamber are: small radius 39 cm, large radius 150 cm, intensity of the stabilizing toroidal magnetic field $4 \cdot 10^6$ A/m on the plasma axis, and rated plasma current up to 800 kA. Tests performed with a current of 400 kA and a stabilizing of $2.8 \cdot 10^6$ A/m yielded a maximum plasma density of $1 \cdot 10^{14}$ cm⁻³, an electron temperature of 1 keV, an ion temperature of 0.7 keV sufficient to ensure intensive physical thermonuclear $d+d \rightarrow p + p + \gamma$ reactions with a neutron flux of $(4-8) \cdot 10^9$ per second, and an energy containment time of 0.06 s. The test data agree closely with the results of computer simulations of heating processes and heat balance. A higher performance requires additional plasma heating, besides Joule heating, possibly by both injection of fast neutral 20-100 keV atoms and rf or microwave methods. A great deal of further development will be necessary, however, before the Lawson performance criterion can be met. Figures 5.

USSR

A NEW SPONTANEOUSLY FISSILE ISOTOPE

Moscow PRIRODA in Russian No 11, Nov 77 pp 149-150

FLEROV, G. N., TER-AKOP'YAN, G. M., POPEKO, A. G., FEFILOV, B. V., and SUBBOTIN, V. G., Nuclear Reactions Laboratory at the Joint Institute of Nuclear Research, Dubna

[Abstract] A residual concentration of hyperheavy elements with Z= 110-126 remaining in meteorites such as carbonaceous and unstable chondrites after evolution of the solar system is deemed entirely probable. Recently in a salt mine at a depth equivalent to a 1100 m thick water bed there has been detected and recorded a multiple neutron emission from samples of meteorites Yefremovka, Saratov, and Allende. Two, three, and four neutrons have been picked up simultaneously, which is much above the level of combined ambient emission from the spontaneously fissile uranium impurity in these meteorites, due to fissioning of transuranium isotopes deposited on the meteorite surface from the atmosphere, due to interaction of the meteorite material with cosmic muons, and due to instrument noise. This phenomenon is attributed to the presence of some spontaneously fissile long-lived isotope. The average number of neutrons released during a single fission is estimated to be within 4-10, which eliminates uranium and heavier known isotopes. The concentration of this new isotope in meteorites should be within $3 \cdot 10^{-15}$ - $3 \cdot 10^{-14}$ g/g, assuming a lifetime of about 10^9 years.

USSR

UDC 517.946

SOME OPTIMALITY PROBLEMS IN REACTOR KINETICS

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA MATEMATICHESKAYA in Russian
Vol 41, No 5, Sep/Oct 77 pp 1170-1198 manuscript received 14 Feb 73 and
14 Apr 76

KUZNETSOV, YU. A. and MOROZOV, S. F.

[Abstract] The necessary conditions of optimality in two problems of reactor kinetics are established mathematically in terms of Pontryagin's maximum principle, by variation of functionals and finding the functional increments from the solution to the conjugate system of equations. The first optimality problem involves a fixed control time where the control function appears in the nonhomogeneous term (source) as well as in the damping coefficient of the integrodifferential equations of reactor kinetics and where an integral functional with a zero upper limit is to be minimized. The second problem is one of optimum response speed with the integral limit constrained by a bilateral inequality. References 27: 14 Russian, 13 Western.

Optics and Spectroscopy

USSR

UDC 621.372.8:621.315.61+539.219.3

MAKING OPTICAL WAVEGUIDES IN BARITE CROWN AND BARITE FLINT GLASSES BY SOLID-STATE DIFFUSION OF SILVER AND COPPER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2254-2257 manuscript received 14 Feb 77

ALESHKEVICH, N. I., VOYTENKOV, A. I., RED'KO, V. P., Mogilev Affiliate of the Institute of Physics, Academy of Sciences USSR

[Abstract] The article gives the results of studies of the diffusion of silver and copper into crown, barite crown and barite flint glass. Thin films of chemically pure silver and copper were applied by vacuum sputtering to polished substrates of the investigated glasses. The coefficients of transmission and reflection were measured in the 300-900 nm wavelength range by a differential method on the SF-16 spectrophotometer. During diffusion, the transmission spectra were studied and the waveguide indices of refraction were measured on a wavelength of 0.63 μ m after each heat treatment. Diffusion was done at the annealing temperature of the glass substrate. It was found that silver diffusion waveguides can be made only in the presence of oxygen, and their copper analogs can be made only in vacuum. The results of the experiments showed that the rate of diffusion of silver is independent of the composition of the glass, and is determined by the viscosity of the glass at the instant of diffusion. The losses of light in the copper diffusion waveguides were somewhat higher than in the silver counterparts. The most suitable materials for copper diffusion waveguides should be multiple-alkali silicate glasses. Figures 3; references 6: 5 Russian, 1 Western.

USSR

UDC 621.372.8

INVESTIGATION OF TUNNEL EXCITATION AND RADIATION OF OPTICAL DIFFUSE WAVEGUIDES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2196-2202 manuscript received 17 Dec 76

ZOLOTOV, YE. M., PELEKHATYY, V. M., PROKHOROV, A. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] The authors investigate stimulated emission of E- and H-waves by the tunnel mechanism in diffuse waveguides. The experiments were done on 14-mode and 3-mode waveguides made by thermal diffusion of silver into glass. Excitation through uniform and wedge-shaped gaps was studied. The results of the experiments show that the tunnel mechanism can be used for coupling laser radiation into a diffuse waveguide with efficiency of about 85%. The authors thank Ye. A. Shcherbakov for assistance with the work and V. A. Kiselev for constructive criticism. Figures 6; references 12: 6 Russian, 6 Western.

USSR

UDC 538.566:621.731

CONCERNING THE PROBLEM THAT THE INFLUENCE OF ATMOSPHERIC TURBULENCE HAS ON SURFACE SCATTERING OF WAVES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4, No 10(64), Oct 77 pp 2135-2140 manuscript received 16 Nov 76

BELOV, M. L. and ORLOV, V. M.

[Abstract] An examination is made of the problem of determining the power picked up by a receiver with arbitrary directional pattern when partly coherent emission is reflected from a surface with random reflectivity. The Huygens-Kirchhoff principle is used to find an expression for the received power for a photodetector located close to the focal plane of a lens. Simpler expressions are given for three important cases: 1. where the distance between the incident and received beams is much greater than the correlation radii of the phase S and the logarithm of amplitude χ ; 2. where the distance between source and receiver and their dimensions are much less than these correlation radii (strict backscattering); 3. where the distance between the incident and received beams is much greater than the correlation radius for χ , but much less than that for S, and the transverse dimensions of the beams are much greater than the correlation radius for χ . An example is given for reflection from a Lambert surface for the first case. Figures 3; references 10: 9 Russian, 1 Western.

USSR

UDC 535.51

DEPOLARIZATION OF LIGHT BY CYLINDRICAL TWO-LAYER FIBER OPTICS

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22, No 10, October 77 pp 1658-1666 manuscript received 26 Jan 77; after revision, 4 Apr 77

KUCHIKYAN, L. M. and VOLYAR, A. V., Simferopol State University

[Abstract] Depolarization of light in an optical channel can be due to scattering by various structural inhomogeneities, due to a phase shift between components of the electric field vector upon total reflection, and due to birefringence produced by a temperature gradient during extrusion and by differences in thermal expansivities. The first cause is disregarded here, as being irrelevant in the case of fiber optics, while the other two are analyzed on a theoretical basis. The results are compared with and confirmed by those of an experiment in which the polarization characteristics of light in two-layer fiber optics were measured at different propagation angles and at various annealing temperatures up to 500°C, with or without a sheath. Figures 4; references 8: 7 Russian, 1 Western.

USSR

UDC 535.241.13:534:535.31

MINIATURE OPTOACOUSTIC DEVICES WITH PRISM OPTICS

Minsk IZVESTIYA AKADEMII NAUK BELORUSSKOGO SSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 5, Sep/Oct 77 pp 71-72 manuscript received 15 Mar 77

PILIPOVICH, V. A. and SHCHERBAK, YU. M., Institute of Electronics, Academy of Sciences of the Belorussian SSR

[Abstract] Optoacoustic diffraction cells for deflecting a laser beam must be sufficiently wide to ensure the necessary resolution and sufficiently thin to reduce the power of the high-frequency control signal. Cylindrical lenses or prism systems are used for transforming a circular section of a light beam to an elliptic one, by respective expansion and compression along two axes. An optoacoustic device for use with prism pairs has been developed which combines small size (1.5x30x30 mm) with simplicity of manufacture and easy adjustment. It is mounted between two pairs of complementary prisms of reversing the light beam through 180°, each transforming the cross section of the light beam without changing the direction of the latter, adjoining them along the idle lateral surfaces. The light beam, following a helical trajectory through the system, passes through each prism pair twice and the number of necessary prism pairs is thus reduced to half. The prisms are made of grade TF5 glass. With the appropriate refractive index, the dimensions of the deflecting system can be minimized regardless of the characteristics of the optoacoustic cells. Figures 1; references 4: 2 Russian, 2 Western.

USSR

UDC 535.35

LUMINOSITY FIELD OF A DIFFUSE SOURCE IN A STRATIFIED LIGHT-SCATTERING MEDIUM

Minsk IZVESTIYA AKADEMII NAUK BELORUSSKOGO SSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 5, Sep/Oct 77 pp 67-71 manuscript received 29 Apr 77

IVANOV, A. P., GAVRILOVICH, A. B., BARUN, V. V., and BOYKO, P. B., Institute of Physics, Academy of Sciences of the Belorussian SSR

[Abstract] The luminosity field of an isotropic source in a multilayer scattering medium is analyzed on the basis of experimental data and their evaluation in dimensionless cylindrical coordinates. The medium in this study consists of three horizontal plane-parallel layers of different optical densities, with the bottom layer bounded underneath by a diffusively reflecting surface and with the absorption in all three layers negligible. The results indicate to what extent the reflective properties of a surface affect its visibility. They also indicate that the reflection becomes more diffusive farther away from the source, with the albedo of the base surface affecting

the luminosity most significantly. Measurements with the extreme apertures of $1^{\circ}40'$ and 180° of the receiver yielded similar angular luminosity distributions at all horizontal distances. Figures 3; references 7: 6 Russian, 1 Western.

USSR

UDC 53.08

EXPERIMENTAL DETERMINATION OF THE PROBABILISTIC CHARACTERISTICS DESCRIBING THE REFLECTION OF OPTICAL PULSES BY A WATER SURFACE

Gor'kiy IZVESTIYA VUZOV, RADIOFIZIKA in Russian Vol 20, No 10, Oct 77
pp 1573-1574 manuscript received 19 Mar 76

LEBED'KO, YE. G., POKROVSKIY, YU. P., SIMOVSKIY, R. A., and IVANOV, V. I.,
Leningrad Institute of Precision Mechanics and Optics

[Abstract] An experiment was performed to study the reflection of optical pulses by a wavy surface of sea water. Radiation pulses of 1 W power and 0.1 μ s width were transmitted to the surface at a 1 kHz repetition rate. The water surface was agitated at one end by means of fans and tranquilized at the other end. The reflected pulses were fed to a photo receiver and from there through an amplifier and a threshold device with an adjustable signal-to-noise ratio to a counter. The divergence angle of the incident beam was made to match the ratio of illuminated area to average water wavelength. The results of these measurements yield the statistics of pulse reflections by an agitated water surface. The probability distribution of such a pulse reflection is shown here as a function of the collimation angle, indicating the existence of an optimum beam divergence angle. Also shown is the probability distribution of the amplitude of reflected pulses exceeding a threshold level at various divergence angles of the incident beams. The probability of picking up large-amplitude pulses is found to decrease monotonically with increasing divergence of the incident beam, everywhere except within the range of low threshold levels and here it is maximum at some divergence angle. Figures 3; references: 2 Western.

USSR

UDC 538.56:535

SELF-FOCUSING OF INCOHERENT LIGHT BEAMS IN A RANDOMLY NONHOMOGENEOUS MEDIUM.
EFFECT OF CRITICAL OPALESCENCE

Tor'kiy IZVESTIYA VUZOV, RADIOFIZIKA in Russian Vol 20, No 10, Oct 77
pp 1534-1545 manuscript received 22 Dec 75; after revision, 20 Apr 77

BETIN, A. A. and PASMANIK, G. A., Scientific Research Institute of Radiophysics

[Abstract] Random variations in the refractive index largely affect the self-focusing of light beams during passage of intensive optical radiation through a condensate. This process in media with a random distribution of inhomogeneities is analyzed here for the two extreme cases of a broadband and a narrow-band scattering indicatrix. In the first case the principal lobe of the radiation pattern is exponentially attenuated and scattering by small-scale fluctuations of the refractive index produces a broad side lobe. In the second case scattering broadens the entire radiation pattern in a quasi-diffusional manner and self-focusing beyond the range of linear scattering occurs as it does with multimode beams. The theory of this process is based on a parabolic equation for the complex amplitude of the electric field intensity in a nonlinear randomly nonhomogeneous medium through which electromagnetic radiation propagates, with small-scale and large-scale fluctuations of the refractive index considered separately. The results of the analysis are applied to substances in a near-critical (threshold) state, to scattering by small-scale fluctuations (in low-molecular fluids) and by large-scale fluctuations (in high-molecular fluids). In both cases the power threshold of self-focusing can be lowered appreciably with either single-mode focused or sufficiently narrow beams of continuous radiation. Figures 1; references 14: 12 Russian, 2 Western.

USSR

UDC 621.372.8:621.315.6

THREE-DIMENSIONAL DIFFRACTION GRATINGS FOR INTEGRAL OPTICS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 235, No 1, Jul 77 pp 86-88
manuscript received 21 Mar 77

VOZHEVOL'NYY, S. I., ZOLOTOV, YE. M., KISELEV, V. A., PELEKHATYY, V. M.,
PROKHOROV, A. M., academician and SHCHERBAKOV, YE. A., Physics Institute
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A method of producing three-dimensional diffraction gratings in optical glasses is proposed which involves covering the substrate surface with a periodic masking structure and then selectively increasing the refractive index of the surface layer by diffusion of silver or lead ions. Such gratings with a geometrically quasinsinoidal profile were obtained experimentally on grade K-8 glass with a 2000 Å thick aluminum coating and a photoresist coating, upon irradiation with an interference-pattern beam from an He-Cd laser. The resulting optical profile was found to eventually approximate a parabolic-exponential one yielding a field intensity modulation with a Bessel-function characteristic. Figures 2; tables 1; references 8: 2 Russian, 6 Western.

Superconductivity

USSR

ONE-BAND PROPERTIES OF "DIRTY" TWO-BAND SUPERCONDUCTORS

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[Abstract] The ordering parameters at absolute zero temperature as well as the superconducting transition temperature and the energy gap of a superconductor with a high concentration of nonmagnetic impurity are calculated on the basis of the two-band model. The results, in the extreme case of a weak link, correspond to those for a pure one-band superconductor and thus prove P. W. Anderson's postulate. References 5: 3 Russian, 2 Western.

CSO: 1862

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